

Contents

	Page
Appendix A, Biological Assessment/Screening Level Risk Assessment/Biological Opinion	
Appendix A1, Biological Assessment	
A1–1.0 Introduction	A1–1
A1–2.0 Species Evaluated	A1–3
A1–2.1 Critical Habitat	A1–3
A1–3.0 Consultation to Date	A1–4
A1–4.0 Description of the Proposed Action	A1–5
A1–4.1 On-Site (Moab) Remedial Actions	A1–5
A1–4.2 Off-Site Remedial Actions	A1–9
A1–4.3 Moab Site Ground Water Remedial Actions	A1–9
A1–4.3.1 Proposed Action	A1–9
A1–4.3.2 Remediation Goals for Contaminants of Concern	A1–10
A1–4.3.3 Initial and Interim Actions Related to the Proposed Action	A1–11
A1–4.3.4 Ground Water Remediation Options	A1–12
A1–4.3.5 Implementation and Operation	A1–16
A1–5.0 Description of Project Areas	A1–17
A1–5.1 Moab Site	A1–18
A1–5.1.1 Terrestrial Setting	A1–18
A1–5.1.2 Aquatic Setting	A1–19
A1–5.2 Klondike Flats	A1–20
A1–5.3 Crescent Junction	A1–22
A1–5.4 White Mesa Mill	A1–24
A1–6.0 Borrow Areas	A1–26
A1–6.1 Crescent Junction Borrow Area	A1–26
A1–6.2 Floy Wash Borrow Area	A1–27
A1–6.3 Courthouse Syncline Borrow Area	A1–27
A1–6.4 Klondike Flats Borrow Area	A1–27
A1–6.5 Tenmile Borrow Area	A1–27
A1–6.6 Blue Hills Road Borrow Area	A1–28
A1–6.7 LeGrand Johnson Borrow Area	A1–28
A1–6.8 Papoose Quarry Borrow Area	A1–28
A1–6.9 Blanding Borrow Area	A1–28
A1–6.10 White Mesa Mill Borrow Area	A1–28
A1–7.0 Analysis for Aquatic Species	A1–29
A1–7.1 Species Accounts and Status in the Proposed Action Area	A1–29
A1–7.1.1 Colorado Pikeminnow	A1–29
A1–7.1.2 Razorback Sucker	A1–32
A1–7.1.3 Humpback Chub	A1–33
A1–7.1.4 Bonytail	A1–34
A1–7.2 Potential Effects of Proposed Actions on Aquatic Species	A1–34
A1–8.0 Analysis for Terrestrial Species	A1–42
A1–8.1 Species Accounts and Status in the Proposed Action Area	A1–42
A1–8.1.1 Jones' Cycladenia	A1–43
A1–8.1.2 Navajo Sedge	A1–44
A1–8.1.3 Clay Phacelia	A1–44
A1–8.1.4 Bald Eagle	A1–45

A1–8.1.5	California Condor	A1–46
A1–8.1.6	Mexican Spotted Owl	A1–47
A1–8.1.7	Southwestern Willow Flycatcher	A1–49
A1–8.1.8	Black-Footed Ferret	A1–54
A1–8.1.9	Western Yellow-Billed Cuckoo	A1–56
A1–8.1.10	Gunnison Sage Grouse	A1–58
A1–8.1.11	White-Tailed Prairie Dog	A1–59
A1–8.2	Potential Effects of Proposed Actions on Terrestrial Species	A1–60
A1–9.0	Determinations and Conclusions.....	A1–63
A1–9.1	Determinations for the On-Site Disposal Alternative	A1–64
A1–9.2	Determinations for the Off-Site Disposal Alternative	A1–66
A1–9.3	Determinations for Ground Water Remediation.....	A1–69
A1–9.4	Determinations for the No Action Alternative.....	A1–71
A1–9.5	Conclusions.....	A1–72
A1–10.0	List of Contributors, Preparers, and Contacts	A1–74

Appendix A2, Screening Level Risk Assessment

A2–1.0	Introduction	A2–2
A2–1.1	Screening of Contaminant Data for Aquatic Biota Assessment	A2–2
A2–2.0	Screening for Terrestrial Biota.....	A2–2
A2–3.0	References	A2–2

Appendix A3, Biological Opinion (under development by USF&WS)

Appendix B, Assumed Disposal Cell Cover Conceptual Design and Construction

B1.0	Introduction	B–1
B2.0	Current Design Concept.....	B–1
B3.0	Construction.....	B–3
B3.1	Side Slope Construction	B–3
B3.2	Top Slope Construction	B–3
B3.3	Construction-Related Features and Objectives	B–4
B3.3.1	Vegetation	B–4
B3.3.2	Erosion Control.....	B–4
B3.3.3	Frost Protection	B–4
B3.3.4	Biointrusion Control	B–4
B4.0	White Mesa Mill Site Disposal Cell Cover.....	B–5
B5.0	References	B–5

Appendix C, Slurry Pipeline Route Maps

Appendix D, Human Health

D1.0	Introduction	D–1
D2.0	Radiation and Human Health.....	D–1
D3.0	Future Potential Risks	D–5
D3.1	Exposure Assessment	D–5
D3.1.1	Current Site Conditions.....	D–5
D3.1.2	Future Site Conditions	D–6
D3.1.3	Summary	D–7
D3.1.4	Exposure Assumptions.....	D–7
D3.2	Toxicity Assessment	D–8
D3.2.1	Noncancer Effects	D–8

D3.2.2	Carcinogenic Effects	D-9
D3.2.2.1	Nonradionuclides	D-9
D3.2.2.2	Radionuclides.....	D-9
D3.3	Risk Characterization.....	D-10
D3.3.1	Risk Characterization Methods.....	D-10
D3.3.1.1	Exposure Estimation	D-10
D3.3.1.2	Risk Characterization.....	D-12
D3.4	Risk Evaluations for the On-Site and Off-Site Disposal Alternatives.....	D-14
D3.5	Backup Calculations	D-14
D4.0	Construction Risks	D-52
D5.0	Air Quality	D-100
D6.0	References.....	D-106

Appendix E, Evaluation of Disposal of Moab Tailings in Salt Caverns Within the Paradox Formation

E1.0	Introduction.....	E-1
E2.0	Conceptual Approach.....	E-2
E2.1	Cavern Construction	E-3
E2.2	Brine Disposal	E-3
E2.3	Tailings Slurry	E-5
E2.4	Tailings Disposal	E-5
E2.5	Oil, Gas, Potash, and other Mineral Resources	E-5
E2.6	Property Ownership	E-6
E2.7	Permitting	E-6
E3.0	Cost Estimates.....	E-7
E4.0	Advantages and Disadvantages of Salt Cavern Disposal	E-9
E5.0	Conclusions.....	E-10

Appendix F, Floodplain and Wetlands Assessment for Remedial Action at the Moab Site

F1.0	Introduction.....	F-1
F2.0	Project Description.....	F-3
F2.1.	Proposed Actions at the Moab Site—On-Site Disposal Alternative	F-4
F2.1.1	Remediation of Contaminated Materials	F-4
F2.1.2	On-Site Disposal Cell	F-4
F2.1.3	Ground Water Remediation	F-4
F2.1.4	Borrow Areas	F-5
F2.2.	Off-Site Disposal Alternative	F-5
F3.0	Floodplain and Wetlands Descriptions	F-5
F3.1.	Moab Site.....	F-5
F3.2.	Klondike Flats Site	F-7
F3.3.	Crescent Junction Site.....	F-7
F3.4.	White Mesa Mill Site.....	F-9
F3.5.	Borrow Areas.....	F-9
F3.5.1	Areas with No Floodplains or Wetlands	F-9
F3.5.2	Blue Hills Road Borrow Area.....	F-11
F3.5.3	Courthouse Syncline Borrow Area	F-11
F3.5.4	Floy Wash Borrow Area	F-11
F3.5.5	Tenmile Borrow Area	F-11
F3.5.6	White Mesa Borrow Area	F-11
F4.0	Floodplain and Wetlands Impacts.....	F-14

F4.1.	Moab Site—On-Site Disposal Alternative	F-14
F4.1.1	Floodplains.....	F-14
F4.1.2	Wetlands	F-15
F4.2.	Off-Site Disposal—Klondike Flats.....	F-15
F4.3.	Off-Site Disposal—Crescent Junction.....	F-15
F4.4.	Off-Site Disposal—White Mesa Mill	F-16
F4.5.	Borrow Area Impacts.....	F-16
F5.0	Summary	F-17
F6.0	References.....	F-17

Appendix G, White Mesa Mill Operations

G1.0	Introduction	G-1
G2.0	Background	G-1
G3.0	Facility	G-2
G4.0	Operations	G-2
G5.0	Air and Radiological Emissions.....	G-4
G6.0	Past and Recent Production	G-5
G7.0	Transportation	G-5
G8.0	References.....	G-6

Appendix H, Transportation Impact Analysis

H1.0	Introduction	H-1
H1.1	Incident-Free Transportation Impacts.....	H-1
H1.1.1	Incident-Free Collective Dose Scenarios	H-2
H1.1.2	Incident-Free Maximally Exposed Individual Exposure Scenarios.....	H-3
H2.0	Transportation Accident Impacts	H-3
H2.1	Transportation Accident Rates	H-4
H2.1.1	Severity Categories, Conditional Probabilities, and Release Fractions	H-4
H2.1.2	Shipment Inventories	H-5
H2.1.3	Atmospheric Conditions	H-5
H2.1.4	Exposure Pathways	H-6
H2.1.5	Health Risk Conversion Factors	H-6
H3.0	Shipments.....	H-6
H4.0	Results.....	H-8
H4.1	Transportation Impacts	H-8
H4.1.1	On-Site Disposal Alternative	H-8
H4.1.2	Klondike Flats Off-Site Disposal Alternative	H-9
H4.1.3	Crescent Junction Off-Site Disposal Alternative	H-9
H4.1.4	White Mesa Mill Off-Site Disposal Alternative	H-10
H4.2	Incident-Free Radiation Doses to Maximally Exposed Individuals	H-11
H4.2.1	On-Site Disposal Alternative	H-11
H4.2.2	Klondike Flats Off-Site Disposal Alternative	H-11
H4.2.3	Crescent Junction Off-Site Disposal Alternative	H-12
H4.2.4	White Mesa Mill Off-Site Disposal Alternative	H-12
H4.3	Impacts from Severe Transportation Accidents	H-13
H4.3.1	On-Site Disposal Alternative	H-13
H4.3.2	Klondike Flats Off-Site Disposal Alternative	H-13
H4.3.3	Crescent Junction Off-Site Disposal Alternative	H-14
H4.3.4	White Mesa Mill Off-Site Disposal Alternative	H-15
H5.0	References.....	H-15

Tables

Table A1–1. Species Considered in the 2004 BA for the Moab Site, Moab, Utah	A1–3
Table A1–2. Estimated Area of Disturbed Land at Borrow Areas for the Remediation Activities at the Moab Site, Moab, Utah.....	A1–7
Table A1–3. Status of Aquatic Species	A1–29
Table A1–4. Status of Terrestrial Species	A1–43
Table A1–5. Summary of DOE Determinations for the On-Site Surface Disposal Alternative	A1–65
Table A1–6. Summary of DOE Determinations for the Off-Site Surface Disposal Alternative	A1–67
Table A1–7. Schedule for Meeting Ground Water Remediation Goals	A1–69
Table A1–8. Summary of DOE Ground Water Remediation Determinations	A1–70
Table A2–1. Minimum, Maximum, Background Range, Total Number of Samples, and Number of Samples Above Detection Limit for Contaminants of Potential Concern at the Moab Site, Utah (2000–2002 data)	A2–5
Table A2–2. Chemical Benchmarks for Assessing Potential Impacts to Aquatic Organisms From Inorganic Contaminants of Potential Concern at the Moab Site, Utah (2000–2002 data).....	A2–6
Table A2–3. Comparison of Contaminants of Concern to Associated Benchmarks for Aquatic Biota at the Moab Site (page 1 of 2).....	A2–7
Table A2–4. Surface Water Concentrations of Contaminants With Minimum Mammal NOAEL- and LOAEL-Based Drinking Water Benchmarks and Piscivorous Mammal NOAEL- and LOAEL-Based Food/Water Benchmarks.	A2–27
Table A2–5. Surface Water Concentrations of Contaminants with Minimum Bird NOAEL- and LOAEL-Based Drinking Water Benchmarks and Piscivorous Bird NOAEL- and LOAEL-Based Food/Water Benchmarks.	A2–28
Table A2–6. Maximum Concentrations of Contaminants in Surface Water With the Number of Sample Values (not including background) at or Above Minimum Mammalian and Avian NOAEL- and LOAEL-Based Drinking Water Benchmarks and Minimum Piscivorous Mammal and Bird NOAEL- and LOAEL-Based Food/Water Benchmarks.....	A2–29
Table A2–7. Background Range and On-Site and Downgradient Range and Mean Concentrations of Metals in the Freshwater Aquifer and Soil Solution Phyotoxicity Benchmarks	A2–43
Table A2–8. Maximum and Mean Concentrations of Radioactive Constituents Evaluated Using the RESRAD Biota Code.....	A2–43
Table B–1. Technical Basis and Assumptions for Components of the Assumed Cover Design.....	B–2
Table D–1. Risk of Latent Cancer Fatalities and Other Health Effects from Exposure to Radiation	D–4
Table D–2. Scenarios, Exposure Facts, Abbreviations, References (Overview Sheet)	D–16
Table D–3. No Action—Future Incidental Ingestion of Contaminated Soil by a Resident	D–18
Table D–4. No Action—Future Exposure to Contaminated Produce Grown Adjacent to a Residence	D–19
Table D–5. No Action—Future Dermal Exposure to Contaminated Ground Water for an Outside Worker	D–21

Table D-6. No Action—Future Incidental Ingestion of Contaminated Soil During Camping	D-23
Table D-7. No Action—Future Dermal Exposure to Contaminated Ground Water During Camping	D-25
Table D-8. No Action—Future Ingestion of Contaminated Ground Water by a Camper	D-27
Table D-9. No Action—Current Dermal Exposure to Contaminated Ground Water During Rafting	D-29
Table D-10. No Action—Current Incidental Ingestion of Contaminated Ground Water by a Rafter	D-31
Table D-11. On-Site—Exposure Point Concentrations	D-32
Table D-12. On-Site—Risk Summary for the Residential Scenario (Adult)	D-35
Table D-13. On-Site—Risk Summary for the Residential Scenario (Children)a	D-36
Table D-14. On-Site—Risk Summary for the Rafting Scenario (Children)a	D-37
Table D-15. On-Site—Risk Summary for the Camping Scenario (Adult)	D-38
Table D-16. On-Site—Risk Summary for the Camping Scenario (Children)	D-39
Table D-17. On-Site—Risk Summary for the Outside Worker Scenario (Adult)a	D-40
Table D-18. On-Site—Overall Summary for All Receptors and Pathways	D-41
Table D-19. Off-Site—Exposure Point Concentrations	D-42
Table D-20. Off-Site—Risk Summary for the Residential Scenario (Adult)	D-45
Table D-21. Off-Site—Risk Summary for the Residential Scenario (Children)a	D-46
Table D-22. Off-Site—Risk Summary for the Rafting Scenario (Children)a	D-47
Table D-23. Off-Site—Risk Summary for the Camping Scenario (Adult)	D-48
Table D-24. Off-Site—Risk Summary for the Camping Scenario (Children)a	D-49
Table D-25. Off-Site—Risk Summary for the Outside Worker Scenario (Adult)a	D-50
Table D-26. Off-Site—Overall Summary for All Receptors and Pathways	D-51
Table D-27. Klondike Flats Disposal Alternative—Truck	D-53
Table D-28. Klondike Flats Disposal Alternative—Truck Summary	D-56
Table D-29. Klondike Flats Disposal Alternative—Rail	D-57
Table D-30. Klondike Flats Disposal Alternative—Rail Summary	D-60
Table D-31. Klondike Flats Disposal Alternative—Slurry	D-61
Table D-32. Klondike Flats Disposal Alternative—Slurry Summary	D-64
Table D-33. Crescent Junction Disposal Alternative—Truck	D-65
Table D-34. Crescent Junction Disposal Alternative—Truck Summary	D-68
Table D-35. Crescent Junction Disposal Alternative—Rail	D-69
Table D-36. Crescent Junction Disposal Alternative—Rail Summary	D-72
Table D-37. Crescent Junction Disposal Alternative—Slurry	D-73
Table D-38. Crescent Junction Disposal Alternative—Slurry Summary	D-76
Table D-39. White Mesa Mill Disposal Alternative—Truck	D-77
Table D-40. White Mesa Mill Disposal Alternative—Truck Summary	D-80
Table D-41. White Mesa Mill Disposal Alternative—Slurry	D-81
Table D-42. White Mesa Mill Disposal Alternative—Slurry Summary	D-84
Table D-43. Summary of Construction and Transportation Fatality Estimates for the Disposal Alternatives	D-85
Table D-44. On-Site Worker Summary	D-86
Table D-45. Klondike Flats, Crescent Junction, White Mesa Mill Worker Summary	D-88
Table D-46. Tailings Piles Worker Risks	D-90
Table D-47. Vicinity Property Workers	D-91
Table D-48. Vicinity Property Public Risks—On-Site, Klondike Flats, Crescent Junction, and White Mesa Mill Disposal Alternatives	D-92

Table D–49. Vicinity Property Public Risks–No Action Alternative	D–94
Table D–50. Off-Site MEI.....	D–95
Table D–51. Off-Site Population Public.....	D–96
Table D–52. On-Site Disposal MEI.....	D–97
Table D–53. On-Site Disposal Alternative Radon Risks (Off-Site Population)	D–98
Table D–54. Moab Post NRC Cover	D–99
Table D–55. Equipment List for On-Site Disposal Alternative	D–100
Table D–56. Equipment List for Off-Site Disposal Alternative.....	D–101
Table D–57. Emission Factors Used for Construction Equipment.....	D–101
Table D–58. Emissions for On-Site Disposal Alternative.....	D–102
Table D–59. Emissions for the Moab Site, the Floy Wash Borrow Area, the Klondike Flats Borrow Area, and the Crescent Junction Borrow Area for the Off-Site Disposal Alternatives.....	D–102
Table D–60. Tailpipe Emissions at the Klondike Flats, Crescent Junction, and White Mesa Mill Disposal Sites	D–102
Table D–61. Dust Emissions from Construction Activities at the Klondike Flats, Crescent Junction, and White Mesa Mill Disposal Sites	D–103
Table D–62. Criteria Pollutant Concentrations from Emissions at the Moab Site for the On-Site Disposal Alternative	D–103
Table D–63. Criteria Pollutant Concentrations from Emissions at the Floy Wash Borrow Area for the On Site Disposal Alternative.....	D–103
Table D–64. Criteria Pollutant Concentrations from Emissions at the Klondike Flats Borrow Area for the On-Site Disposal Alternative.....	D–104
Table D–65. Criteria Pollutant Concentrations from Emissions at the Moab Site for the Klondike Flats, Crescent Junction, and White Mesa Mill Disposal Alternatives	D–104
Table D–66. Criteria Pollutant Concentrations from Emissions at the Klondike Flats Site for the Klondike Flats Disposal Alternative	D–104
Table D–67. Criteria Pollutant Concentrations from Emissions at the Crescent Junction Site for the Crescent Junction Disposal Alternative	D–105
Table D–68. Criteria Pollutant Concentrations from Emissions at the White Mesa Mill Site for the White Mesa Mill Disposal Alternative	D–105
Table D–69. Criteria Pollutant Concentrations from Emissions at the Floy Wash, Klondike Flats, and Crescent Junction Borrow Areas for the Klondike Flats, Crescent Junction, and White Mesa Mill Disposal Alternatives	D–105
Table D–70. Criteria Pollutant Concentrations at the Arches National Park Entrance from Emissions at the Moab Site.....	D–106
Table E–1. Preliminary Estimated Costs for Disposal of the Moab Tailings in Salt Caverns and Comparison to On-Site and Off-Site Alternatives in the EIS	E–8
Table E–2. Major Cost Components for Disposal of the Moab Tailings in Salt Caverns.....	E–9
Table G–1. Air Emission Inventory for Key Criteria Emissions (tons per year)	G–4
Table H–1. Incident-Free Unit Risk Factors.....	H–2
Table H–2. Utah-Specific Accident and Fatality Rates	H–4
Table H–3. Severity Categories, Conditional Probabilities, and Respirable Release Fractions for Truck Accidents	H–4
Table H–4. Severity Categories, Conditional Probabilities, and Respirable Release Fractions for Rail Accidents	H–5

Table H–5. Radionuclide Inventory in Uranium Mill Tailings Shipments	H–5
Table H–6. Number of Shipments for the On-Site Disposal Alternative	H–6
Table H–7. Shipments for Klondike Flats Disposal Alternative	H–7
Table H–8. Shipments for Crescent Junction Disposal Alternative	H–7
Table H–9. Shipments for White Mesa Mill Disposal Alternative	H–8
Table H–10. Shipment Distances.....	H–8
Table H–11. Transportation Impacts for the On-Site Disposal Alternative	H–9
Table H–12. Transportation Impacts for the Klondike Flats Off-Site Disposal Alternative	H–9
Table H–13. Transportation Impacts for the Crescent Junction Off-Site Disposal Alternative	H–10
Table H–14. Transportation Impacts for the White Mesa Mill Off-Site Disposal Alternative	H–10
Table H–15. Incident-Free Radiation Doses for the Maximally Exposed Individual Scenarios.....	H–11

Figures

Figure A1–1. Vicinity of the Moab Site	A1–2
Figure A1–2. Typical Cross Section of Disposal Cell, On-Site Disposal Alternative	A1–6
Figure A1–3. Location of Alternative Disposal Sites and Borrow Areas	A1–8
Figure A1–4. Predicted Maximum Ammonia Concentrations in Ground Water for Active Remediation	A1–10
Figure A1–5. Area of Proposed Active Ground Water Remediation	A1–13
Figure A1–6. Klondike Flats Alternative Disposal Site	A1–21
Figure A1–7. Crescent Junction Alternative Disposal Site	A1–23
Figure A1–8. White Mesa Mill Alternative Disposal Site	A1–25
Figure A1–9. Predicted Maximum Ammonia Concentrations in Ground Water for the No Action Alternative	A1–72
Figure A2–1. Aerial view of the Moab site in 2001 identifying the locations of the tailings pile, Moab Wash, Colorado River, upstream background sampling location, and the Matheson Wetlands Preserve	A2–2
Figure A2–2. Evaluation of Contaminants of Potential Concern for Chemical Impacts to Aquatic Biota at the Moab Site.....	A2–2
Figure A2–3. Sampling Results for Ammonia in Surface Water at the Moab Site.....	A2–2
Figure A2–4. Sampling Results for Uranium in Surface Water at the Moab Site	A2–2
Figure F–1. Colorado River, Floodplains, and Potential Wetlands at the Moab Site	F–2
Figure F–2. Klondike Flats Site and Location of Spring Near the Blue Hills Road Borrow Area	F–8
Figure F–3. Drainages That May Contain Riparian Vegetation and Possible Wetlands Near the White Mesa Mill Borrow Area	F–10
Figure F–4. Potential Wetland Near the Floy Wash Borrow Area	F–12
Figure F–5. Location of Wash Near the Tenmile Borrow Area	F–13